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INVESTOR IN PEOPLE

The Patent Office  
Concept House  
Cardiff Road  
Newport  
South Wales  
NP10 8QQ

REC'D 28 OCT 2004

WIPO

PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

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Dated

18 October 2004

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The  
Patent  
Office

21JUL03 0824012-1 B13908  
P01/7700 0.00-0316970.3

1/77

# Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

THE PATENT OFFICE  
J  
19 JUL 2003  
NEWPORT

The Patent Office

Cardiff Road  
Newport  
South Wales  
NP9 1RH

1. Your reference

~~IP-01~~ P059 W0

2. Patent application number

(The Patent Office will fill in this part)

19 JUL 2003

0316970.3

3. Full name, address and postcode of the or of each applicant (underline all surnames)

08647403001

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

Biofresh Ltd  
c/o Room 570, Ridley Building  
University of Newcastle  
Claremont Road  
Newcastle upon Tyne  
NE1 7RU

4. Title of the invention

An Apparatus for the Ozone Protection of Crops

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

~~As Above~~

HANCOCKS ELSWORTH, FFS1/77  
ROTTERDAM HOUSE,  
116 QUAYSIDE,  
NEWCASTLE-UPON-TYNE,  
NE1 30Y.

13/10/04  
JH

Patents ADP number (if you know it)

~~N/A~~

08353526001-

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

N/A

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

NA

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
  - c) any named applicant is a corporate body.
- See note (d))

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# Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description

0

5 (X2)

Claim(s)

0

Abstract

0

Drawing(s)

1 (X2)

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Date

17/7/03

12. Name and daytime telephone number of person to contact in the United Kingdom

Dr Jeremy Barnes 0191 222 7374

## Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

## Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- Write your answers in capital letters using black ink or you may type them.
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- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.

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## An Apparatus for the Ozone Preservation of Crops

Post-harvest losses of fresh produce due to spoilage organisms are a significant problem world-wide for the horticultural and agricultural industries, resulting in reductions in both quantity and quality of marketable produce. Economic losses occur in every part of the supply chain from farm to supermarket. Spoilage in storage and transit is known in some cases to be as high as 30%, equivalent to a lost value of £2 billion per annum to the United Kingdom industry. Current treatments provide poor control of the problem. One major treatment method involves chlorine-based products which are environmentally hazardous.

An ozone enriched atmosphere is an attractive alternative treatment for inhibiting spoilage of horticultural produce. Although a highly reactive oxidant, ozone rapidly degrades to the normal molecular form of oxygen and so environmental disposal is not a problem. There is, however, a problem in that the ephemeral nature of the gas, makes the provision of a useful concentration, maintained for a lengthy period, and within the likes of a transit container, a crop store, or a food handling plant, extremely difficult. In addition, its highly oxidising nature, can result in the produce receiving doses of ozone that damage the crops themselves, rather than merely inhibiting the process of microbial action.

Recent discoveries have indicated that by maintaining a concentration of between fifty parts per billion, and five-hundred parts per billion by volume, of ozone, in air, its efficacious effect of inhibiting spoilage organisms is maintained whilst the crops themselves are not damaged. We were also surprised to discover that by subjecting

perishable horticultural produce to the concentrations of ozone as defined above, resulted in a preservative effect lasting significantly beyond the period of exposure. This novel finding indicates that low ozone levels can stimulate plant defence mechanisms required to prevent microbial attack.

The current invention relates to an apparatus whose purpose is to generate ozone and distribute it through a matrix containing perishable products, in such a manner that the concentration of ozone in the air is maintained within the prescribed concentration limits of the discovery.

Ozone has long been recognised as an active anti-bacterial agent. It has found wide use in hospitals, for sterilising implements, etc. It is used extensively in water treatment. It has been used for deodorising road transport containers to prevent the tainting of subsequent cargoes. There are examples of its use as an agent to inhibit microbial growth in foodstuffs, one example here being that described in Russian patent RU2174316C2, and there are other examples in the scientific literature. It is apparent, however, from the latter that attempts to reduce spoilage resulting from microbial activity are accompanied by lesions and other deleterious effects to the foodstuff itself. This is because of the relatively high concentrations of ozone that are generally applied, for instance, the Russian patent quoted above mentions concentrations of fifteen parts per million of ozone in air, which is over two orders of magnitude greater in concentration than that prescribed hereunder, and is also seventy-five times greater than the acceptable concentration limit for human exposure.

The invention relates to an apparatus for the provision of ozone gas to a matrix of perishable horticultural produce held within a warehouse, store, container, or food packaging apparatus, such that the volumetric concentration of ozone may, on demand, be maintained at a prescribed level of between fifty parts per billion, and five-hundred parts per billion, (where one billion is equal to one-thousand million), in air. The apparatus comprises an ozone generator, and either a single ozone sensor, or plurality of ozone sensors distributed within the target environment. A feedback controller accepts ozone concentration measurements from the sensor or sensors, and, on the basis of these measurements, and, optionally, together with a model of the gaseous fluid behaviour of the store and the matrix, automatically adjusts the production rate of the ozone generator, with the objective of maintaining the prescribed concentration of ozone throughout the matrix.

Figure 1 is a diagrammatic representation, not to scale, of a typical embodiment of the invention applied to a road transport container.

Figure 2 is a diagrammatic representation, not to scale, of a typical embodiment of the invention applied to a crop store or warehouse.

A typical embodiment of the invention will now be described by way of example, and with the assistance of Figure 1. A container (1), which in this example is a transport container of the type frequently used for the road transport of perishable produce, is equipped with an ozone generator (2), which may be of the conventional type in which a corona, or silent, electrical discharge taking place in a narrow gap is used to disassociate the natural oxygen in the air to subsequently re-combine as ozone, or, preferentially, is of the type described in International Publication number WO

00/14010 "Air Purification Device". A fan (3), which may be integral with the ozone generator, or separate from it, blows the ozone laden air into the container, optionally with the assistance of appropriate distribution ducting (4). Because ozone is heavier than air, it is preferable to introduce it through the ducting (4), attached to the roof of the container, so that it may descend through the produce to the floor, where a return duct (5), enables the air and any remaining ozone to be re-circulated.

In use, the container (1), is filled with perishable produce (6), loaded into crates, (7), which are then stacked within it. In the exemplar embodiment three ozone sensors (8), are sited within the container. Such sensors are preferentially of the tungstic oxide semiconductor type, as described in WO 95/35495, although other sensor technologies, for instance those based on ultra-violet absorption, may be utilised if appropriate. The sensors (8) are strategically positioned within the container to ensure that a representative concentration distribution may be measured by the electronic controller (9), so as to ensure that the prescribed ozone concentrations are maintained, but not exceeded, throughout the volume of the container. The electronic controller (9), receives the measurements made by the ozone sensors (8), and utilising this information, together with a pre-arranged protocol based on the physical parameters of the container (1), the prescribed concentrations of ozone, and optionally, the nature of the produce (6), contained therein, issues commands to the ozone generator (2) to moderate its production of the gas.

In similar embodiments, not illustrated, the ozone generation apparatus may be incorporated within air conditioning equipment, often in the form of refrigeration units as are commonly fitted to vehicle transportation units used for the conveyance of

perishable foodstuffs. Likewise the arrangement is equally applicable to containers used in marine, air and rail transport.

A similar exemplar embodiment is described in Figure 2. In this arrangement a large static store or warehouse (11), for produce (6), is equipped with a plurality of ozone generators (2), a plurality of ozone sensors (8), and one, or optionally a plurality of, electronic controllers (9). Such static stores are frequently equipped with apparatus to control the environment within the store, in particular its temperature and humidity. Where such a system exists, or is planned, it may prove advantageous to make use of the existing fans and ducting associated with it to distribute the ozone.

A further exemplar embodiment, not illustrated, is the application of the apparatus to food handling and packaging machinery, wherein the prescribed ozone environment is applied to perishable horticultural products whilst the product is being handled and packed.



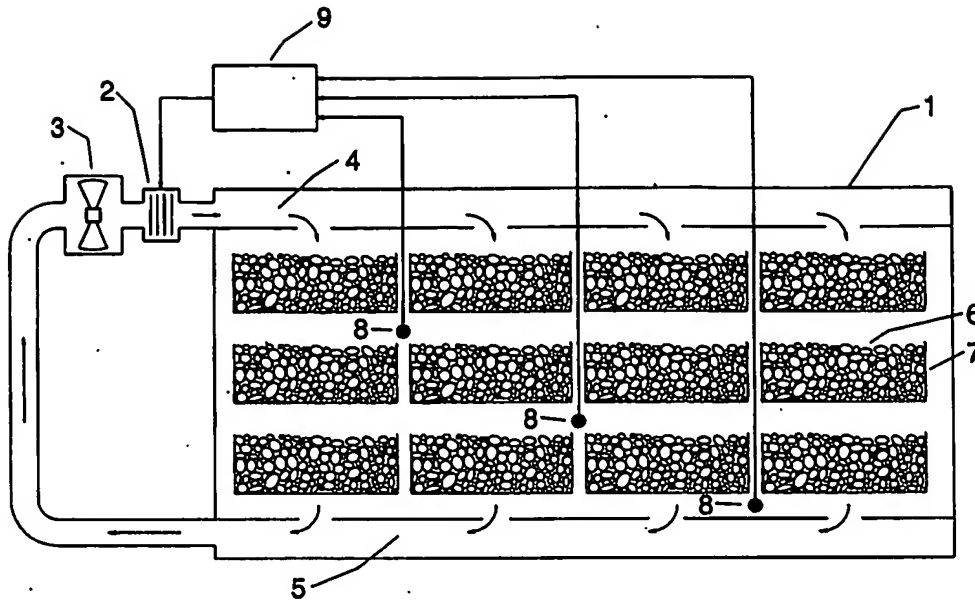


Figure 1

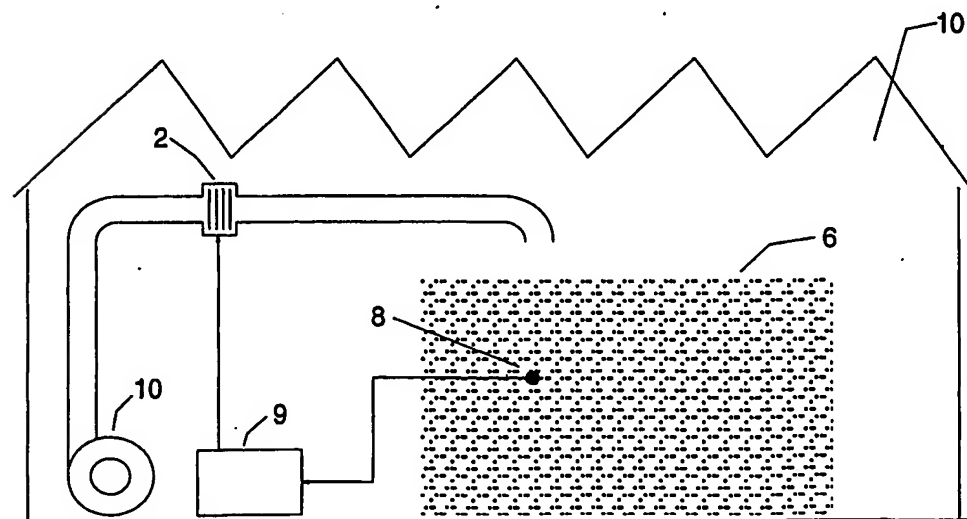


Figure 2